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Can episode-of-care grouper software be used to augment
the military healthcare system modeling efforts?

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Abstract

A computer model that behaves like the healthcare system would be a valuable tool enabling administrators to evaluate the impact of changes to the healthcare system prior to implementation. The Military Healthcare System (MHS) is the leader in creating computerized models that represent large complex healthcare systems. Despite the potential benefits of modeling a healthcare system, modeling remains in its infancy.

The fundamental building block of a healthcare system model is the quantification of care that patients receive as they maneuver their way through the system. Newly-developed software programs known as episode groupers uncover these patterns and organize them into clinically meaningful packages. This study is an exploratory glimpse into the obstacles within the MHS that makes utilizing one of these software products particularly challenging.

A year's worth of healthcare records from San Diego's direct care system, as well as the network, were gathered, formatted, and processed through the episode grouper. MHS data did not perform as well as civilian healthcare data; 23% of the records were ungroupable vice 14%. The majority of these orphan records (70%) were ancillary and pharmaceutical records that could not be linked to the outpatient visit that generated them. Some of the contributing factors include inadequate capture of data within the MHS, the mobility of the population served, military-unique medical codes, and inaccurate coding.

The MHS has made improvements since the time frame of this study that should vastly improve its performance with episode groupers. After additional reliability and validity testing has occurred, episode groupers could be utilized to uncover healthcare delivery patterns and incorporated into the next wave of MHS healthcare computer models.

Introduction

The United States healthcare industry is under tremendous strain. Healthcare administrators are under increasing pressure to find ways to control rising costs, improve the quality of the care delivered, and increase access to care. In order to manipulate the healthcare system so that all three aspects of healthcare (cost, quality, and access) are optimized, an administrator must thoroughly understand the interactions between, and among, the elements of the system. In a system as large and complex as healthcare, small changes in one sector can trigger unexpected, and sometimes costly, repercussions in another. Administrators must have a healthy respect for the integrated nature of such systems. A computer model that behaves like the healthcare system would be a valuable tool enabling administrators to evaluate the impact of changes to the healthcare system prior to implementation.

The United States' military healthcare system (MHS) is the largest in the country incorporating medical assets from three distinct services (the Army, the Air Force, and the Navy) and our civilian healthcare partners. The complexity and scale of such a system require sophisticated computerized models to capture and accurately display the behaviors contained within. Military healthcare administrators interested in encouraging collaboration between services are also attracted by the graphic nature of many computer models. A disparate audience with unique vocabularies and viewpoints such as the three military services can often come to a consensus when presented with a graphical representation of how their healthcare facility operates within the scope of the entire system.

Because very few healthcare organizations are near the size or complexity of the MHS, modeling efforts in the civilian healthcare arena have concentrated on improving operations on a small scale. Modeling programs currently exist that enable administrators to optimize operations on a small scale such as within a single facility. The MHS is the leader in creating computerized models that represent large complex healthcare systems. One of the interesting consequences of building a computer model is that it compels the builder to thoroughly understand the current system. The need to first quantify interactions within the system is, in itself, a very useful exercise (R. E. Thorp, personal communication, November 17, 2000). After the system is understood and interactions have been described and quantified, model construction can begin. Once the computer model “behaves” like reality, administrators are able to experiment with changes in the healthcare system and determine if changes would alter productivity, cut costs, endanger quality, and so on. Despite the potential benefits of modeling a healthcare system, modeling in the MHS remains in its infancy.

The fundamental building block of a healthcare system model is the quantification of care that patients receive as they maneuver their way through the system. While differences exist, there are patterns inherent in the delivery of this care. Uncovering these patterns in healthcare has, historically, been a difficult tedious process. Fortunately, advances in medical information databases and the standardized medical coding systems have made it possible to uncover these patterns using computer software collectively referred to as “episode groupers”. Episode groupers organize encounters between a patient and the healthcare system into clinically meaningful packages. These packages can then be studied to determine care patterns. If this new software can be utilized within the military

healthcare system, administrators would have a tool to help them more thoroughly understand patterns of healthcare delivery within the system. With a deeper understanding of the processes within medicine comes the ability to quantify what has occurred. Quantifying healthcare delivery patterns is the first step in building a healthcare system model. The next generation of computer models could be greatly enhanced by incorporating this new technology.

Condition which prompted the study

The military healthcare system (MHS) has spent over five million dollars on the latest healthcare system model, the Healthcare Complex Model or HCM (M. Burke, personal communication, January 10, 2001). The most fundamental unit of this model is a "protocol" which loosely translates into the amount and type of healthcare delivered to an individual with a certain diagnosis. These protocols, or patterns of care, are constructed from aggregated MHS data in combination with clinical judgment (M. Burke, personal communication, October 27, 2000). The construction and manipulation of these protocols is a costly process because of the manpower involved (M. Burke, personal communication, January 10, 2001). The ability to utilize episode grouper software to uncover and quantify these "protocols" would greatly simplify the process; potentially reducing the cost of model development. In addition, utilizing data from actual patient care patterns versus those created from aggregated data could potentially increase the accuracy of the protocols and thereby enhance the model's representation of reality.

The civilian healthcare sector currently utilizes episode groupers to manage many aspects of their systems. While the utility of this software within the MHS appears

limitless, this paper will concentrate on only one of its possibilities; the potential for episode groupers to augment current healthcare modeling efforts.

Statement of the problem

An understanding of healthcare delivery is essential to the success of any healthcare system model. Patterns inherent in the delivery of healthcare must be uncovered and quantified before they can be represented in a computer model. The study of these patterns has been greatly simplified with the advent of healthcare information databases and standardized medical coding. Commercially-developed software programs known collectively as episode groupers organize disparate encounters with the healthcare system into clinically-meaningful groups. Although the MHS utilizes databases and medical codes, several aspects of the MHS make utilizing this advanced software particularly challenging. The MHS lacks one central storage area for healthcare information so gathering and compiling data necessary for the project may prove burdensome. In addition, coding practices within the MHS may interfere with the performance of the software.

In order to judge the episode grouper's performance with MHS data, a civilian benchmark will be used. When civilian healthcare data is "fed" through the episode grouper used in this study, approximately 86% of their records are incorporated into a pattern of care for an individual. This pattern of care, also known as an episode-of-care, represents all of the care that an individual received in the treatment of a specific illness/disease. The remaining 14% of the records are unable to be grouped to an episode-of-care. These figures remain fairly constant regardless of the amount of healthcare records that are sent through the grouper or the time frame of the study (D. Gardiner, personal communication, March 3, 2001).

The purpose of this project is an exploratory journey into the performance of MHS data with one of the episode grouper products currently on the market. Challenges encountered in the process will be noted and discussed. In addition, the results of the grouping session utilizing MHS data will be compared with the civilian benchmark described above. Finally, an analysis of the usefulness of this type of software in the MHS' current modeling efforts will be provided.

Literature review

Healthcare researchers have long understood that "patterns" existed in the delivery of healthcare. As far back as the 1930's, Lee and Jones documented the typical course of diseases as well as the medical resources employed in the treatment of several specific disease groups (Lee and Jones, 1933). The idea of healthcare patterns regained attention in the 1960's when Scitovsky, a health economist, studied the concept of disease "episodes" in an attempt to price the delivery of healthcare in a more global manner. She proposed that the cost of healthcare be reported to the public (via the medical care price index) based on the average costs of treatment for the entire course of the disease (Scitovsky, 1964). Meanwhile, Solon, Feeney, Jones, Riggs, and Sheps (1967) refined the concept and coined the term "episode-of-care". They studied the traditional means of analyzing healthcare utilization (aggregated visit counts) and realized its limitations. They believed this method of studying utilization failed to accurately reveal the complexity of medical care. Instead, they devoted their attention to the concept of episodes-of-care. They defined an episode-of-care as "a block of one or more medical services received by an individual during a period of relatively continuous contact with one or more providers of service, in relation to a

particular medical problem or situation". Several other principles were offered to clarify this definition. The authors believed that:

1. Episodes-of-care could be constructed around a complaint, an objective symptom, a diagnosed disease, or a health objective.
2. Episodes-of-care would have a beginning, a course of service, and an ending although there would be no absolute time limit on the total length of the episode-of-care.
3. Episodes-of-care may be isolated encounters or they may be related to other episodes-of-care.
4. An episode-of-care should include all of the care delivered regardless of where it occurred.
5. Many stops and starts in service such as remissions and flare-ups may exist naturally within an episode-of-care.
6. Episodes-of-care for different problems may overlap or run simultaneously.

Solon et al. (1967) believed that an episode-of-care framework could be used to identify the most effective and economical management of patients. Once these episodes-of-care were identified and documented, they would become the "standard of care". Physicians, clinical investigators, and epidemiologists could utilize them to identify physicians practicing outside of the standard-of-care. Others soon realized the value of analyzing the delivery of healthcare within an episode-of-care framework. Feldstein (1968) and Scitovsky (1967) believed that an episode-of-care approach to changes in healthcare costs over time would provide useful information to payors who were concerned with

containing costs and predicting demand. Donabedian (1978) emphasized the need to review entire episodes-of-care when assessing quality.

Although an appreciation for the natural patterns in healthcare existed as far back as the 1930's, efforts were greatly hindered by the significant effort involved in collecting the data for study. The medical profession began as a cottage industry. Physicians practiced independently and, in general, without supervision (Sultz & Young, 1999). Documentation of healthcare encounters, if they were maintained at all, remained with the responsible provider. As health insurance became more popular, providers were forced to document the care delivered and share this information in order to receive reimbursement for their work. Soon after, the need to standardize medical documentation became apparent and the current medical coding system was born. The advent of technology led to the creation of medical information databases where documentation of healthcare encounters is stored electronically. These two advances, standardized medical coding practices and the creation of medical information databases, forever altered healthcare research. Suddenly, an enormous amount of healthcare data was available. The challenge then became the analysis of this plethora of data so that meaningful information could be gleaned to facilitate informed decision-making. The first attempts involved clumping individual diagnoses into manageable groups.

Initial attempts to analyze the available data were targeted at better understanding the coding process and the variety of codes used in the ambulatory healthcare setting. Schneeweiss, Rosenblatt, Cherkin, Kirkwood, and Hart (1983) studied insurance claims from ambulatory healthcare visits to devise a system of consolidating the numerous medical codes into meaningful groups. Using the expertise of clinicians and the coding

systems in place at the time, Schneeweiss et al. created “diagnostic clusters”. These diagnostic clusters grouped the vast number of diagnosis codes into a manageable number of clusters. This bundling also helped minimize the idiosyncratic coding patterns of physicians and coders. They found that 80% of all ambulatory visits could be captured in sixty clusters. If the number of clusters was increased to ninety-two, 86% of all visits to office-based physicians could be captured. This categorization of outpatient care into manageable groups using insurance claims was an attempt to better understand the intricacies of healthcare delivery. While this research was promising, the rising cost of healthcare demanded a more aggressive approach to healthcare management.

Managed care organizations gained a foothold in healthcare in the early 1980s with the promise of controlling rising costs (Kongstvedt, 1997). Despite their successes, healthcare costs continued to rise at such an alarming rate that the federal government took action to exploit the advances in technology. Congress’ newly-created Agency for Health Care Policy and Research was tasked with forming large clinical databases using data from the Medicare insurance system, indemnity insurance carriers, health management organizations, and large physician groups. From these databases, the AHCPR was directed to build systems so that care patterns could be analyzed and best clinical practices could be identified (Agency for Health Care Policy and Research, 2001). In 1993, President Clinton’s Health Care Advisory Task Force declared that information systems will be used to monitor and evaluate the health care system, to develop links among health care records to improve patient care, and to analyze patterns of health care. The Clinton administration understood the importance of using an episode-of-care framework to uncover effective

medical practices (Cave, 1994). Unfortunately, the goal of this task force was never realized but it led to a renewed interest in uncovering practice patterns for analysis.

The first computer programs to construct episodes-of-care from insurance claims were designed in the late 1980s and early 1990s. McDevitt & Dutton (1989), Garnick, Luft, Gardner, Morrison, Barrett, O'Neil, and Harvey (1990), and Hillman, Olson, Griffith, Sunshine, Joseph, Kennedy, Nelson & Bernhardt (1992) gathered outpatient encounters into episodes-of-care for specific ambulatory illnesses/conditions. These early attempts were useful but they fell short of the goal of creating comprehensive episodes-of-care because they did not include hospitalizations. The incorporation of inpatient and outpatient care into episodes-of-care would not occur until the mid 1990s.

Cave (1995) developed a computer program that combined disparate inpatient and outpatient records from insurance claims databases into episodes-of-care. These episodes-of-care were then placed into diagnostic clusters based on clinical homogeneity. Cave used a methodology similar to Schneeweiss et al. (1983) but called his clusters "diagnostic episode clusters", or DEC's. His clusters linked all services provided, both inpatient and outpatient, for the care of a patient's medical condition for a specified period of time into clinically homogenous clusters. Cave used 125 DEC's, vice the 92 used by Schneeweiss et al (1983), presumably because of advances in the practice of medicine and changes in the medical coding system. Cave's study is significant for two reasons; the episodes-of-care included both inpatient and outpatient care and they were placed into clinically homogeneous groups so that patients with similar medical conditions could be compared.

Episode groupers are a relatively recent development but possess great potential. In a 1999 article, Drs. Rosen and Mayer-Oakes gathered information about the four most

prominent episode grouper products on the market. They outlined the basic operation of episode groupers, identified potential uses, and outlined some of the problems faced when constructing episodes-of-care. Most episode groupers use the same basic, two-part methodology (Rosen & Mayer-Oakes, 1999).

The first task is the construction of episodes-of-care. Episode groupers search databases, one patient at a time, and examine all the services rendered for that particular patient. The standardized medical code(s) on each encounter is examined and care that was provided in the treatment of a particular illness/condition is grouped together. The chronological sequencing of these individual services forms an episode-of-care. Ideally, episodes-of-care contain all of the care relevant to a particular medical condition/illness to include inpatient, outpatient, ancillary and pharmaceutical care.

The second task involves placing the episodes-of-care into groups with similar patients' episodes-of-care so that meaningful comparisons can be made between the care delivered to individuals within the group. Placing patients into clinically homogenous groups is important because episodes-of-care, by themselves, merely describe the utilization of individual patients. Their true utility comes when individuals are grouped with, and can be compared to, similar patients with comparable medical conditions.

Although episode groupers are relatively new on the market, they are quickly becoming valuable tools for healthcare administrators. They have at least three uses within the civilian healthcare sector; to identify variations in treatment, to measure compliance with clinical practice guidelines, and to assess the impact of health policies. These applications, along with their potential within the MHS, will be briefly discussed below.

Healthcare administrators use episode groupers to identify variations in treatment by comparing the length, cost, and outcome of episodes-of-care. They are especially applicable in a managed care setting because all of an individual's care is provided by, or with permission from, his/her primary care manager. Primary care managers who are responsible for episodes-of-care that differ significantly from their peers (treating the same type of patients) are known as "outliers. The goal of the healthcare administrator is to encourage the high-cost outliers to modify their treatment patterns thereby saving dollars for the system. The low-cost outliers are examined to determine if their methods result in high quality outcomes. If so, they become the standard that everyone is expected to "norm" too. Many researchers have studied this concept of provider profiling and have found it has the potential to alter and improve the practice patterns of providers if the providers believe the methodology employed is valid and the clinical benchmarks are solid (Greco & Eisenberg, 1993). Episode groupers could be very valuable to the MHS if patients and providers within the system enjoyed consistent relationships. Historically, enrollees in the MHS listed a facility as their primary care manager, not a particular provider. When they received medical care, it could potentially be from any of a number of providers in the facility. A recent initiative in the MHS, Primary Care Manager by Name, is designed to match patients and their chosen provider each and every time they seek medical care in order to enhance continuity of care (TRICARE, 2001). Once providers have a stable panel of beneficiaries enrolled to them, they are in a better position to truly "manage" the care their patients receive. Once the system is in place they can also be held accountable for the care delivered to "their" enrollees. Until Primary Care Manager by Name is firmly

established, using episode groupers for provider profiling within the MHS would be without meaning.

Given the present system and the lack of provider accountability, perhaps a better use of episode groupers within the MHS would be to analyze the care delivered to distinct populations. Instead of individual provider profiling, a more useful study might be to profile performance within the MHS against that delivered to the beneficiaries that utilize our civilian partners for their care. This study could potentially reveal which system is the most cost-effective with the best outcomes. Both sides stand to learn something. Or perhaps a comparison of the episodes-of-care for active duty personnel compared to non-active duty beneficiaries. Inequities that are jeopardizing health might be revealed. The goal of all of these studies would be to uncover variations in treatment thereby improving quality. The focus would be on systems vice individual providers.

Administrators also use episode groupers to measure compliance with clinical practice guidelines. Clinical practice guidelines are created/adopted by a facility or healthcare organization to outline the care that patients with a particular disease/condition should receive in their facility. Clinical practice guidelines encompass the inpatient care delivered in a facility, care received as an outpatient, or both (National Guideline Clearinghouse, 2001). They are intended to reduce variation in clinical practice, optimize the healthcare system and provide patients with high quality care. Using episode groupers, the care delivered to individual patients could be monitored to ascertain if care was delivered in accordance with a clinical practice guideline. For example, if the clinical practice guideline recommended a certain medication in the third week of treatment and the medication was absent in the episode-of-care, the responsible provider could be

questioned. Providers who routinely have patients that are not treated in accordance with the facility's established clinical practice guideline, without a clinically sound reason for not following the pathway, could be encouraged to conform. Additionally, if practices are uncovered through analysis of the episode grouper product that resulted in better outcomes, the clinical practice guideline could/should be changed to reflect an advance in medical practice. Using episode groupers to create or monitor clinical practice guidelines within the MHS is an intriguing idea. The volume of data available to administrators demands a tool to assist in analysis. Perhaps the largest obstacle to the use of episode groupers is the ongoing data quality concern within the MHS. Episode groupers are limited in their ability to correct for improperly coded healthcare encounters. They merely organize the existing data into more manageable bundles. However, further study is warranted in this area because clinical practice guidelines have been proven to lower variation and therefore raise the quality of healthcare delivered (Sultz & Young, 1999).

Episode grouper software could be utilized to assess the impact of health policies. If the content of episodes-of-care were compared before and after policy implementation, changes as a consequence of the policy could be noted. For example, a comparison of episodes-of-care before and after the military health insurance co-payment was eliminated might reveal some interesting findings. Once the co-payment was dropped, perhaps patients were more apt to get annual wellness exams. Perhaps no change in the utilization patterns of individuals was noted. Disease management programs are typically developed to help educate beneficiaries and provide opportunities to manage illnesses at home rather than in more costly settings such as the hospital. If a disease management program was implemented, its impact on episodes-of-care could be monitored using episode groupers.

Ideally, hospitalizations for those enrolled in the program would decrease or perhaps the severity of their condition when the provider saw them would be less. A more complete picture of the impact of policy changes is available through analysis of episodes-of-care that include inpatient as well as outpatient care. While the capability of this software is intriguing and warrants further study, the goal of this paper is to assess the potential application of episode groupers to augment the current modeling efforts.

Drs. Rosen and Mayer-Oakes (1999) reviewed four of the most prominent episode groupers on the market. The authors advised that, above all, the episode grouper product selected should:

1. Incorporate inpatient as well as outpatient care.
2. Include pharmaceutical care.
3. Place the episodes-of-care into a manageable number of groups so that researchers and administrators are not encumbered during analysis.
4. Be adjusted for case-mix using age, patient acuity, and co-morbid conditions.

The episode grouper used in this study was developed by Symmetry Health Data Systems, Inc. Symmetry's episode grouper product incorporates inpatient, outpatient, ancillary, and pharmacy data and has some unique processes to adjust for patient acuity. Their episode grouper constructs episodes-of-care and places them into groups called Episode Treatment Groups, or ETGs, to facilitate meaningful comparisons. There are 584 ETGs. The complete list can be found in Appendix A. Symmetry's episode grouper was selected because of its overall capabilities and patented processes that make it unique. A copy of the patent document is included in Appendix B. Symmetry Health Data Systems, Inc, generously provided the use of their episode grouper product, as well as access to their

highly qualified staff, in support of this study. The following section will outline many of the issues to be aware of when working with episode grouper software products. When applicable, its relevance to MHS data and how Symmetry's product handles the issue will be included.

Challenges Facing Episode Groupers

Missing data is one of the many obstacles to comprehensive episode-of-care creation. Thorough documentation of healthcare encounters has always proven elusive. In a capitated setting, providers receive reimbursement because the patient chose to enroll with the provider. The documentation of individual encounters does not impact the provider's salary. Databases for capitated physicians were found to have serious information lapses possibly because their salary is not tied to correctly filling out forms (Wingert, Kralewski, Lindquist & Knutson, 1995). Not surprisingly, when documentation is tied to reimbursement, databases suffer less from missing information (Wingert et al., 1995). Wages for military providers are not connected to documentation of healthcare encounters, therefore, missing data within the MHS is a serious issue.

Two information systems are responsible for documenting encounters that took place at the MTFs; the Ambulatory Data System (ADS) and the Composite Health Care System (CHCS). At the time of the study, fiscal year 2000, the level of expertise with ADS at the MTFs varied a great deal (N. Coppola, personal communication, September 20, 2001). In order to transmit documentation of all outpatient encounters into the central database in Fort Dietrich, Maryland, many manhours and a great deal of effort were necessary. Some clinics were more efficient at the process than others. If ADS was not used correctly, outpatient visits were lost to the system and never reached the storage

database. The impact of the Ambulatory Data System on this study will be explored in the discussion. For now, keep in mind that episode groupers are unable to fill in holes where missing encounters should have occurred. They only report on the encounters that were properly documented.

Incorrect coding on healthcare encounters is a common problem both within the MHS and the civilian sector (Cave, 1995; Fahs, 1992; Hornbrook, Hurtado & Johnson, 1985). The problem has historically received more attention in the civilian healthcare sector because heavy fines are levied for maliciously, incorrectly coding healthcare encounters and coding is directly tied to reimbursement (Physician Insurance Agency of Massachusetts, 2001). A 1999 study of a representative sample of MTFs found disagreement between the codes used in documentation and the codes that should have been used, based on available documentation, when professionals recoded the records. Over 30% of the diagnosis codes and almost 40% of the procedure codes were used incorrectly (Vector Research, Inc, 2000). Poor coding practices within the MHS are receiving increasing attention because administrators realize that far-reaching decisions are being made based on the data. If the information is inaccurate, good decision-making is hindered. Several features within the MHS contribute to poor coding. Most providers are responsible for choosing a medical code for their healthcare encounters regardless of the level of training they have received in this practice. Poor education, or a lack of education, leads to incorrect coding. In addition, medical codes are often recorded on paper forms that are limited in space. Therefore, only the most common medical codes can be included on the forms. This practice encourages the provider to choose among the codes available on the form. If the most appropriate code does not appear on the preprinted form, the provider

is forced to take extra time to search for the appropriate code. Providers might choose to spend the additional time with their patients rather than hunting for the most appropriate medical code. A switch is under way to computerize the process. This new process would encourage providers to find and use more accurate medical codes. However, the system still revolves around the willingness of the provider to search for the most appropriate medical code among the tens of thousands available. As with missing data, Symmetry's software is not designed to compensate for this defect in the data. It can only organize healthcare encounters into episodes-of-care if the encounters are labeled with a clinically-logical medical code. Although Symmetry's episode grouper cannot correct miscoded encounters, it can handle a similar problem; tentative diagnoses.

Providers are often unsure of the true medical cause of the problem but they are forced to document a diagnosis code on the encounter despite their limited knowledge of the case at hand. Oftentimes, this tentative diagnosis changes as the results of diagnostic tests are received, the patient's verbal recollection improves, or the medical condition matures (Rosen & Mayer-Oakes, 1998). Symmetry's episode grouper uses a patented process to handle tentative diagnoses. If the tentative diagnosis is a logical precursor to a more definitive diagnosis, the grouper will include the healthcare encounters for both conditions into the same episode-of-care. This feature is known as "episode shifting" and is discussed in further detail in Appendix C. This feature is equally useful to the MHS and civilian healthcare sectors.

Another aspect of healthcare that makes episode-of-care creation challenging is that healthcare encounters are often electronically stored in several places. This might be due to a change in health insurance, a change in providers, a job change, or a move. A lapse in

health insurance could also be the reason that encounter information is not stored in a central database. Our society is so mobile that it is difficult to capture the care patterns that people experience over a long period of time in a single database. To complicate matters, providers' practices are increasingly more volatile as they sign up with, and disengage from, health insurance plans. In an effort to control the rising costs, patients are often shuttled between levels of care to find the least resource-intensive setting that can accommodate their individual needs. Documentation of this care is likewise spread out among these settings. Thorough episode-of-care construction dictates that all of the care delivered to that individual for the care of his/her condition is included, regardless of where it occurred. Episode groupers must be able to incorporate data from different sources in order to construct comprehensive episodes-of-care. Within the MHS, most of the inpatient and outpatient care delivered to an individual is stored in a central database, however, ancillary care is not. Ancillary care consists of radiological and laboratory tests performed and pharmaceuticals prescribed. Documentation of this care is electronically stored at the military treatment facility (MTF) where the care was delivered in the local version of CHCS. Progress is being made to consolidate all of this information in one central database but as of the time of this study it was not a reality. To overcome this obstacle, data from the different sources must be carefully gathered and patients must be identifiable across databases. A unique patient identifier is essential to link care from one source with related care documented in another source. This identifier is key to finding and incorporating all the care delivered to an individual in many settings across his/her life span. Currently, the MHS does not have a method to uniquely identify individuals in the

system. The process used to create the necessary unique patient identifier in this study is explained in the methodology section.

An episode-of-care can start at several different points based on which entity is defining the episode; the epidemiologist, the patient, or the healthcare system. The epidemiologist would argue that an episode should encompass the entire disease process to include a non-symptomatic period. In contrast, an episode-of-care defined by the patient would begin when the individual first felt ill and may include a lengthy period before they sought medical care. From the healthcare system's perspective, an episode-of-care begins when the patient enters the healthcare system for that particular problem/complaint/need and begins utilizing resources (Hornbrook, 1985; Rosen & Mayer-Oakes, 1998). The latter type of episode exists only while the patient is consuming resources in the healthcare system. It is the type most commonly referred to in the literature because it is the easiest to define and study. This "medical care episode", as it is sometimes called, is the one used by most commercially-produced episode groupers.

Determining the appropriate length for an episode-of-care is another hurdle faced by episode groupers. This issue highlights the complexity of medical care. Solon et al. (1967) believed that the conclusion of an episode-of-care could be reached either by "explicit discharge or withdrawal from care, or by a lapse of suspension sufficient to constitute a distinct break of contact with medical service for a given problem" (p. 404). Researchers have tried to identify rules that help determine the appropriate lengths of episodes. Lohr, Brook, Kamberg, Goldberg, Leibowitz, Keeseey, Reboussin & Newhouse, (1986) studied common respiratory infections and found that the majority of care for a respiratory infection occurred within two weeks after the beginning of the episode. Jette,

Smith, Haley & Davis (1994) studied low back pain in a representative national sample of patients with insurance and found that, on average, episodes-of-care for this population extended over five weeks and consisted of eleven physical therapy visits. Kessler, Steinwachs, and Hankin (1982) tried a different approach to place limits on the length of episodes. They studied psychiatric encounters and determined that an eight-week period of no visits (a clean period) was necessary to establish the end of one, and the beginning of another, separate psychiatric episode. Stoddart and Barer (1981) found that for most illnesses a clean period of fifteen days or more was almost sure to indicate that the new episode under study was not related to, or a continuation of, the previous episode. Salkever, Skinner, Steinwachs & Katz (1982) discovered that for sore throats, a three-week clean period nestled in between a long string of visits to the doctor was sufficient to declare that one sore throat episode had ended and a new sore throat episode had begun. Rosen, Houchens, Gibson, & Mayer-Oakes (1998) derived clean periods for asthma based on empirical and clinical data. According to her methodology, even within one disease, clean periods vary significantly. In sum, the research indicates that medical diagnoses are so unique that it is impossible to create one rule that adequately delineates all the possible episode endings. Symmetry's episode grouper has patented their process of determining the start and finish of episodes-of-care. What follows is a simplification of the process. A more detailed explanation can be found in Appendix C.

Symmetry's episode grouper allows an episode-of-care to continue as long as the patient is receiving care for that condition. The episode length remains flexible and is not predetermined. The boundaries on an episode-of-care are established by setting limits on the length of time between encounters. The period of time between encounters (when the

patient is not receiving care) is known as a clean period. Each Episode Treatment Group, or ETG, has its own unique parameters for clean periods. These boundaries are based on what has been found in the literature and from prior episode-of-care creation sessions. If the period of time before the episode-of-care begins meets, or exceeds, the clean period parameter established for that ETG, the episode-of-care has a “clean start”. If the period of time after the episode-of-care ends meets, or exceeds, the clean period parameter established for that ETG, the episode-of-care has a “clean finish”. This flexibility in the lengths of episodes is especially appealing to clinicians who understand the complexity of medical care and the chronicity of certain conditions.

If a patient has two episodes-of-care that fall under the same ETG separated by a clean period of sufficient length to meet, or exceed, the clean period parameters, the two episodes are considered distinct and separate episodes-of-care. Clean periods are further divided into: (a) The length of time that an individual must go without contact with a healthcare provider, and (b) how long they must go without receiving medications for a condition. Typically, the software looks for pharmaceutical records longer than it looks for visits in an attempt to capture medication refills. Refills would indicate that the person was still receiving medical care for a particular condition and the episode-of-care would be extended. The medical and pharmaceutical clean periods are distributed with the software. The ability to explore these parameters is vital to clinicians suspicious of the grouping process and its outcomes. The clean period parameters for each ETG are available in Appendix A.

Episodes-of-care that enjoy a “clean start” and a “clean finish” (the period of time before and after care meets or exceeds the parameters) are labeled “complete” episodes-of-

care. All other episodes are placed into categories that describe aspects unique to them. Appendix D contains a list of the eight different types of episodes. The ability to distinguish between episodes-of-care that contain all the care received for that condition, and those that may not, is important when analyzing the care patterns of the responsible clinicians. Symmetry advises caution when drawing conclusions utilizing episodes-of-care that are not considered complete.

Another problem episode groupers face is that quite often patients receive medical care for more than one medical condition at a time. These concurrent illnesses complicate the construction of episodes-of-care. If the illnesses do not impact one another (i.e. a broken ankle and a cold) then care must be taken to ensure so that all units of care are correctly assigned to the appropriate episode-of-care. If the illnesses do impact, or confound, one another they are known as co-morbid conditions and deserve to be handled carefully. The episode-of-care for each of the conditions is distinct but the impact of one illness upon the episode-of-care for the other must be accounted for. The ability to sort out these separate or confounding conditions is crucial to the eventual usefulness of the episode grouper products. Symmetry's episode grouper has patented its process to adjust for co-morbid conditions. The software maintains a separate file of patients with diagnoses that could complicate the treatment of other medical conditions. As new episodes-of-care for a patient are identified, the co-morbid conditions file is queried for medical conditions that may impact the episode-of-care under investigation. If a co-morbid condition for that particular patient is identified, the current episode-of-care is placed in an ETG that includes other patients with co-morbid conditions. This is done so that clinically similar patients are

grouped together to facilitate meaningful comparisons regarding the treatment they receive.

Another challenge in episode construction are the complications that occur during medical treatment; whether through a natural occurrence or because of human error. Hornbrook et. al (1985) formulated episode-of-care rules that stated naturally-occurring complications should be treated as part of the original episode-of-care. This might also provide guidance on what to do with patients that have an illness such as cancer that naturally progresses into, and out of, remission. According to Hornbrook et al. (1985), periods of remission should be considered an extension of the original cancer episode-of-care. Human error can also complicate medical treatment. For complications that result from other-than-natural means (i.e. human mistakes), Hornbrook et. al (1985) did not provide guidance. Symmetry's episode grouper accounts for complications that occur during medical treatment, regardless of the source. Complicating conditions present in the episode-of-care place it in a group (ETG) with patients having similar complicating conditions.

One of the most important features of any episode grouper is its ability to adjust for patient acuity when it places individuals into groups for comparison. As discussed above, Symmetry's episode grouper adjusts for co-morbid conditions and for complications that arise during medical treatment. In addition, it takes two other factors into account to ensure that patients grouped together under the same ETG are clinically similar enough to justify a meaningful comparison of the care they each received. Several of Symmetry's ETGs are adjusted for age; others require the presence of a particular surgical procedure for

admission into the ETG. Together, these four factors are designed to adjust for case mix so that meaningful comparisons between the patients in each ETG can be made.

Databases and Medical Coding Systems

Databases contain information in rows called records and columns called fields (Prague & Irwin, 1999). Each record represents an interaction between a patient and the healthcare system. Each record is made up of many fields (columns). The terms “record” and “field” will be used often throughout this paper. In addition to some familiarity with database terminology, a general understanding of the relevant medical coding systems is important. The three standard medical coding systems used in this paper are explained in Appendix E. They include diagnosis, procedure and pharmaceutical codes.

The actual operation of Symmetry’s episode grouper software is explained in detail in Appendix C. The goal of any episode grouper is to create comprehensive episodes-of-care that include as much of the actual care delivered as possible. Most records fit neatly into an episode-of-care; others will not. In Symmetry episode grouper, all records, even if they are not destined to become part of an episode-of-care, are linked to an ETG. Of the 584 ETGs, the last eleven have been designated to hold the “ungroupable” records. The “ungroupable” ETGs contain useful information; if solely to identify problems so that more of the records can be linked to an episode-of-care. Healthcare administrators analyze the ungroupable records to determine why those records failed to be included in an episode-of-care and to reduce the number if possible. Appendix F is a list of the ETGs that contain the ungroupable records.

Hypothesis

This study hinges on how well MHS data performs with Symmetry Health's episode grouper. The differences between the MHS data systems and civilian healthcare data systems are few enough that complete failure would be unexpected. As noted earlier, civilian healthcare organizations can expect approximately 86% of their records to be included in an episode-of-care. The remaining 14% are said to be ungroupable and can be found in the eleven ungroupable ETGs. This figure remains fairly constant regardless of the amount of records that are sent through the episode grouper and the time frame of the data pull (D. Gardiner, personal communication, March 3, 2001). This is the benchmark that MHS data performance will be measured against.

The test used will be the z test for comparing proportions of two independent samples. The formula, as well as the null and alternate hypothesis, are listed below.

$$z = (p_1 - p_2) / \text{SQRT} (p_{pd})(q_{pd})(1/n_1 + 1/n_2)$$

$$H_0: p_1 = p_2$$

$$H_a: p_1 \neq p_2$$

The null hypothesis states there is no statistical significant difference between the proportion of records labeled ungroupable when MHS data is sent through Symmetry's episode grouper and the proportion of ungroupable civilian records. The alternate hypothesis states there is a statistically significant difference between the proportion of ungroupable MHS records and the proportion of ungroupable civilian records.

Methodology

This study consists of three separate tasks; data collection/formatting, running the data through the grouper, and analysis of the output. San Diego, California, was chosen as the study site because it has a large active duty population and the information management department was willing to supply the necessary data. Military beneficiaries in the San Diego area have access to care through one of two systems; the direct care system (military facilities) and/or the network (civilian healthcare partners that accept TRICARE health insurance). For a true picture of the care delivered to our military beneficiaries, both systems must be represented in the episodes-of-care. The military treatment facilities included in the study are Naval Medical Center San Diego and its subordinate commands. See Appendix G for a list of the military facilities in the San Diego area that were included in the study. The civilian healthcare facilities included in the study are those that fall within a 40-mile radius of Naval Medical Center San Diego. The timeframe of the data pull was fiscal year 2000; October 1, 1999 through September 31, 2000. This time period was chosen as a compromise between two competing forces. Data quality in the MHS continues to receive more and more scrutiny so, theoretically, the quality of the data would be highest in recent records. However, pulling data that is too recent does not allow sufficient time for the records in the civilian network system to be submitted for reimbursement and thereby included in the database. Fiscal year 2000 seemed a reasonable choice.

Prior to pulling the data, the layout of the final database had to be configured. Requirements were based on the specifications of the episode grouper and the needs of the study. The layout of the final database can be seen in Appendix H. The fields essential to

proper functioning of the episode grouper are shaded. The accuracy of this step was critical for several reasons. First, the data pulls for this study required many manhours and created extremely large, cumbersome files. Because of time restraints and the reasons stated above, requesting additional data pulls because of an error in judgment was not a viable option. In addition, the three large files pulled by the Information Management Department (IMD) at the Naval Medical Center San Diego had to be transferred securely because of the sensitive information the files contained. The cooperation and effort necessary from all parties involved was intense and requesting additional data pulls would not be feasible given the time restraints of the project and the demanding schedule of the IMD. Therefore, there was little room for error when selecting the fields to be pulled.

The most rudimentary and obvious fields required by the episode grouper were those necessary to construct an identifier unique to each patient. As noted earlier, this field does not presently exist in the MHS information systems. For this study, a patient identifier was created by combining three fields that were present in each of the data sources. The fields were descriptive of the patient in that record but not necessarily unique to that patient. They included the gender of the patient, the patient's date of birth, and the sponsor's social security number. Theoretically, combining these fields would create an eighteen character alphanumeric digit that would be unique to that individual. The only situations in which it would not work would be for same sex, multiple births born on the same day or a family that incorporated an individual with the same birthday and sex as an existing member of the family. While this occurrence may be rare, any conclusions drawn using this method of creating a unique patient identifier should remain tentative until this possibility has been explored.

As noted before, healthcare records for the MHS are electronically stored in different places. The large database in Fort Dietrich, Maryland, houses inpatient and outpatient records from MTFs and inpatient, outpatient, and ancillary care records from our civilian partners. This data is made available through the All-Region Server, otherwise known as the ARS Bridge. Documentation of ancillary care provided at the MTFs remains at the local level where the care was delivered. The Information Management Department at Naval Medical Center San Diego assisted in pulling the laboratory tests, radiology tests and medication prescriptions provided by the MTFs in the San Diego area. This data is stored in the local application of the military's healthcare encounter system, the Composite Health Care System (CHCS). For information about the ARS Bridge and/or the CHCS system, see Appendix I. Eight different types of records from two different sources (ARS Bridge and CHCS) were necessary to this study. Each record represents a different type of care delivered to eligible beneficiaries. Eliminating even one of these sources would have greatly reduced the comprehensive nature of the episodes-of-care.

The data arrived in several different forms; spreadsheet, text file, and database file. A backup copy was made of the original source files and stored safely away. All of the files were converted into tables in Microsoft's database program; Access. Access has size limitations (one gigabyte per table, two gigabytes in a database) that made manipulation of the data difficult at times, but it proved adequate for the task at hand. The following table provides details about the source of the data, what type of care was represented in the records, and the number of records in the files. It is readily apparent that the majority of the workload (85%) is handled by the MTF facilities in the San Diego area. The remaining 15% is provided by the military's civilian partners in the network.

Table 1

Data Source

Source	Type of care	Number of records	Percent of total
CHCS	Prescriptions filled at MTF pharmacies	1,762,693	38.37%
ARS bridge	Outpatient visits in MTFs to include provider/patient interactions and ancillary care other than laboratory and radiology	989,460	21.54%
CHCS	Laboratory tests performed at MTFs	950,025	20.68%
ARS bridge	Outpatient visits with network providers, prescriptions from civilian pharmacies	671,861	14.62%
CHCS	Radiological tests performed at MTFs	196,230	4.27%
ARS bridge	Hospitalizations in MTFs	20,947	0.46%
ARS bridge	Hospitalizations in civilian facilities	2,347	0.05%
ARS bridge	Prescriptions filled through the NMOP	743	0.02%
	TOTAL	4,594,306	

Visual inspection

A visual inspection of a sample of the records was completed to identify potential problems. A few situations required additional information from Symmetry Health Data Systems, Inc. to determine if the existing data would work with their episode grouper. Other situations were clearly not conducive to the proper functioning of the episode grouper. In these cases, corrective action(s) were taken with the necessary steps outlined

below. Manipulation of the data was purposefully kept to a minimum to limit the introduction of operator error and to formulate a realistic estimate of the effort necessary to prepare data for the episode grouper. The visual inspection revealed:

1. Despite the fact that they reside in the same database, the format of MTF inpatient records is different from those submitted by the civilian network. An entire hospitalization that occurred in a MTF is recorded as one inpatient record. A hospitalization in the civilian network system is often recorded as several inpatient records with contiguous, but not overlapping, dates. Symmetry Health was contacted regarding this difference in formatting. The solution was to program the grouper to search the data for multiple records that make up one hospitalization. This would consolidate the appropriate civilian inpatient records in the network system but would not disturb the already consolidated MTF inpatient records.
2. Civilian outpatient records contain the professional claims (admitting physician, consulting physician, and anesthesiology fees) for the civilian inpatient records. The MTF outpatient records do not include professional services as a separate record; these services are bundled into the inpatient records. This difference would not affect the functioning of the episode grouper.
3. The 149,932 civilian outpatient records that represent pharmacy claims lack a pharmacy (NDC) code which would indicate what medication was prescribed and greatly assist in placing the record with an ongoing episode-of-care. However, the majority of these records (99.8%) are coded with a medical diagnosis (ICD-9) code. Unfortunately, the diagnosis code on all of these records is 7998; an extremely vague code that translates into a "miscellaneous" diagnosis. Symmetry Health was

contacted regarding the above. Pharmacy claims without an NDC code or a specific diagnosis (ICD-9) code could not be linked to an ongoing episode-of-care. These records would be labeled as “ungroupable” and would fall into one of the eleven ungroupable ETGs. The episodes-of-care that these pharmacy claims rightfully belong in will not have them included.

4. MTF outpatient records have multiple procedure codes for each record. The episode grouper only recognizes one procedure code per record; procedure codes subordinate to the primary position would be disregarded.
 - a. 147,928 records (14.95%) had a procedure code in the 2nd position
 - b. 67,526 records (6.82%) had a procedure code in the 3rd position
 - c. 31,147 records (0.03%) had a procedure code in the 4th position
 - d. Procedure codes in subordinate positions in the MTF outpatient records were brought to the primary position in newly-created MTF outpatient records. Each newly-created MTF outpatient record contained information identical to its parent record (i.e. sponsor SSN, date of service, primary diagnosis, etc.) except for the procedure code. This increased the number of MTF outpatient records from 989,460 to 1,236,061; an increase of 24.9%.
5. Telephone consults are captured in the direct care system as outpatient records but are not captured in the network system. While this fact does not impact the current study, analysis comparing episodes-of-care in the MHS to those occurring in the civilian sector must take this into account.
6. The Primary Care Manager (PCM) ID field in the MTF outpatient records was pulled in order to identify the provider responsible for the care provided. At the

time of the data pull, this field was not populated. Plans are underway to populate this field in conjunction with the Primary Care Manager by Name initiative discussed earlier. Once this field is populated and the information it contains is accurate, the MHS is in a much better position to utilize episode groupers for provider profiling. Although space was included in the final database for this field, the field remained blank.

7. A few MTF outpatient records had information missing that was necessary to create a unique patient identifier. These records were eliminated because they had the potential to create fictitious patients. The care delivered in these records was lost and was not included in the episodes-of-care. If the numbers involved were more significant in future studies, a different approach might be warranted.
 - a. 94 records lacked the sponsor's social security number
 - b. 136 records lacked the patient's date of birth
8. A few records (1,116) had "unknown" listed in the gender field vice "male" or "female". These records were left in the database. It is highly probable that all records for these particular individuals were coded with an "unknown" gender and therefore would match up when the unique patient identifier was created using the gender field.
9. The radiology tests received from Naval Medical Center San Diego's CHCS system were not coded using the standard 5-digit, procedure (CPT-4) codes. The records were coded with a four-digit procedure code that is unique to that MTF. Naval Medical Center San Diego was contacted regarding the four digit procedure codes. A file was provided that mapped the four-digit, facility-specific procedure

code to the standard, five-digit procedure code. The codes were successfully substituted in all but three records. This step could easily be eliminated in the future with more detailed instructions to the data pullers.

10. Records from DMIS ID 0414 (San Clemente Island) cease after 03APR00. Naval Medical Center San Diego was contacted regarding this absence of data. The system to transmit healthcare records to the database in Maryland, (ADS), was non-operational for this particular clinic during the latter half of fiscal year 2000 (N. Coppola, personal communication, September 20, 2001). Fortunately, the number of healthcare encounters generated by providers on San Clemente Island is small. Of the ten facilities that fall under the purview of Naval Medical Center San Diego, they typically generate the least amount of patient encounters. The absence of six months of data from this particular MTF would not greatly impact the study.
11. Records from two MTFs in the San Diego area were not represented in the data; the Branch Medical Clinic on North Island's Naval Air Station (DMIS ID 0231) and the Branch Medical Clinic onboard the Naval Amphibious Base San Diego (DMIS ID 0233). Exactly why this occurred is unclear; the original data puller is unavailable for comment. Traditionally, North Island's clinic is the second busiest clinic in the San Diego area; while the clinic at the Naval Amphibious Base is the second slowest. The impact of this missing information on the study will be discussed later in the paper.

Formatting Process

After the records were visualized and decisions made regarding the data content and potential problems, the formatting process began. The steps involved in formatting the data

are described below in the order they were performed. To avoid redundant language, the creation of backup copies is not mentioned after each step but backup copies were judiciously created as the formatting process unfolded. In addition, the utility function in Microsoft Access to "compact and repair" databases was used regularly in an effort to control the size of each of the tables. The formatting steps include:

1. Each record had a field added entitled "Data source". This field would be necessary to readily identify where the record had originated. The identifiers used to populate this field were:
 - a. SADR for MTF outpatient records
 - b. SIDR for MTF inpatient records
 - c. HCSRN for civilian outpatient and ancillary/pharmacy records
 - d. HCSRI for civilian inpatient records
 - e. CHCSR for MTF radiology tests
 - f. CHCSL for MTF laboratory tests
 - g. CHCSP for MTF prescriptions
 - h. NMOP for pharmacy records from the National Mail Order Pharmacy program
2. A field entitled "Provider type" was added to all records. This is a field required by the episode grouper. It indicates what type of provider was responsible for the service. One of three codes was used to populate this field; "C" for clinician, "F" for facility, or "O" for other. The method for determining which code to use is provided in Appendix J.

3. A field entitled "Type of service" was added to all records. This is another field required by the episode grouper. One of three codes was used to populate this field; "M/S" indicates medical/surgical services were provided, "R&B" indicates the standard room and board services provided in an inpatient setting, or "Anc" which indicates the provision of an ancillary service such as radiological or laboratory tests. The method for determining the correct code to use is provided in Appendix J.
4. Field names in the tables were changed to match the field name used in the final database. This standardization of field names would greatly facilitate the melding of tables later on.
5. Field lengths were changed in the tables to match the field length used in the final database. This would help limit the size of the tables.
6. All records were sorted according to the sponsor's SSN and imported into one of four newly-created databases. The breakdown of the SSNs, listed below, was effective in creating four databases of roughly the same size. For proper operation of Symmetry's episode grouper, all of a patient's records must be located next to one another. Grouping the records by the sponsor's SSN was the first move in this evolution.
 - a. Database A had SSNs 000-00-0000 through 299-99-9999
 - b. Database B had SSNs 300-00-0000 through 499-99-9999
 - c. Database C had SSNs 500-00-0000 through 559-99-9999
 - d. Database D had SSNs 560-00-0000 through 999-99-9999

7. Each of the four new databases, A through D, contained several tables. The largest table in each database was designated the anchor table and was modified to accurately resemble the specifics of the final database, see Appendix H. The other tables were melded into this anchor table. Each of the four databases, A through D, now contained only one large table.
8. Dashes were removed from the SSNs because the episode grouper is unable to recognize "dashes".
9. Encryption of the SSNs was essential to protect patient confidentiality. Encryption ensures that the number cannot be traced back to the original patient but remains a constant, albeit disguised, identifier for each individual. Encryption of the SSNs was accomplished through a separate software program.
10. Dates were formatted to the episode grouper specifications; YYYYMMDD.
11. The "Last date of service" field is essential to the proper functioning of the episode grouper. Only records from a hospital stay had a date in the "Last date of service" field. This date was indicative of the day the individual was discharged from the inpatient facility. In all other records the field was blank because the record indicated that the service had begun and ended on the same day; i.e. same-day service. Through a series of queries, the records with nothing in the "Last date of service" field were populated with the same date found in the "First date of service" field.
12. The episode grouper requires each patient in the database have a unique identifying number. It can consist of letters or numbers but it must be unique to that person. An additional field entitled "Patient ID" was added to all of the records. Three existing

fields (the individuals' gender, the individuals' date of birth, and the encrypted sponsor's SSN) were combined in the Patient ID field to create a unique, eighteen-digit, patient identifier.

13. As noted earlier, the episode grouper demands that all of a patient's records be grouped together. In addition, they must be in chronological order. The records were sorted by patient and placed in chronological order using these fields in this sequence: "Patient ID", "First date of service", and then "Last date of service".
14. Two fields necessary to the functioning of the episode grouper; "Amount charged" and "Amount paid", were added to the database. Both fields were left blank. Dollar amounts for the care provided was not included in the study because reimbursement levels were not the focus of the study.
15. A field entitled "ETG info" was added to all tables but was left blank. This field is necessary for proper functioning of the episode grouper. Information generated during the grouping process is written into this space and the entire file is returned to the customer.
16. At this point, all of the data was contained in one of 4 databases. The records were sorted by patient and were in chronological order. All of the fields necessary to the grouping process were present. The data represented the care delivered to military beneficiaries in the San Diego area during fiscal year 2000. The table below contains information about the data before it was sent through the grouper. The four tables were saved as text files and written to a CD-rom. A backup copy of the CD-rom was made and the data was ready to be "fed" to Symmetry's episode grouper.

Table 2

Description of Pre-Grouper Data

Description	Amount
Initial number of records	4,594,306
Number of records created when all procedure codes were brought to the primary position	246,601
Records deleted for lack of identifying information (SSN or date of birth)	230
Final count of records	4,840,677
Number of individuals represented in sample	280,936
Mean age of individuals represented in sample	32.9 years

Results

Symmetry's episode grouper worked quickly; it took less than three hours to "group" the more than 4.8 million records. The original file was returned with pertinent information attached to each record in the "ETG info" field. Symmetry's episode grouper places all records into one of two categories; those that grouped to an episode-of-care and those that did not. More than three-fourths of the records, 77.1%, were able to be linked to an episode-of-care and were assigned the appropriate ETG. The ETGs populated, in order of occurrence, are included in Appendix K. The remaining 22.9% of the records were unable to be linked to an episode-of-care and were captured in one of the eleven "ungroupable" ETGs. As noted previously, the civilian benchmark for Symmetry's episode grouper is 86% grouped and 14% ungroupable. The MHS' performance of 77.1% and 22.9%, respectively, will be analyzed in the following section.

Statistical analysis

The statistical test used was the z test for comparing proportions of two independent samples. The formula is listed below. Table 3 illustrates the figures used in the calculation.

$$Z = (p_1 - p_2) / \text{SQRT} (p_{pd})(q_{pd})(1/n_1 + 1/n_2)$$

Table 3

Figures Used in Statistical Calculation

Symbol	Explanation	Number
p_1	proportion obtained from MHS data	0.229
p_2	proportion obtained from civilian data	0.140
q_1	$1-p_1$	0.771
q_2	$1-p_2$	0.860
p_{pd}	pooled proportions	0.18540
q_{pd}	pooled q	0.81550
n_1	number of MHS records	4,840,677
n_2	number of civilian records	4,840,677
z		356.959

$$H_0: p_1 = p_2$$

$$H_a: p_1 \neq p_2.$$

The obtained z was 329.5, with a $p < .001$, therefore, the null hypothesis was rejected; the alternate hypothesis was accepted. There is a statistically significant difference between the proportion of ungroupable MHS records and the proportion of

ungroupable civilian records. However, it is worth noting that with sample sizes of this magnitude ($n > 4.8$ million), even a very small difference in the proportions would have caused the null hypothesis to be rejected. The practical significance of the differences in the proportions needs to be considered before summarily accepting the results of the statistical test.

The following investigation into the ungroupable ETGs highlights many interesting facts about MHS data gathered for this study. Healthcare researchers must understand why records are unable to be grouped to episodes-of-care so that data problems can be overcome. A very small portion of records, if any, should stand alone and not be included in an episode-of-care. Investigating why records failed to group to episodes-of-care is as important as celebrating the records that were successfully integrated into an episode-of-care.

Review of ungroupable ETGs

Symmetry's episode grouper has eleven ETGs that contain the "ungroupable" records. The ETG description provides some explanation as to why the record failed to be included in an episode-of-care and facilitates analysis by healthcare researchers interested in improving the quality of the output. See Appendix F for a list of the eleven ETGs. Only ten of the eleven ETGs were populated in this study. This missing ETG, #994, normally contains records that have an "invalid provider type" code. This field was populated during the formatting phase of the project in accordance with the specifications of the episode grouper. No records grouped to ETG #994 because this field was populated completely and with the correct codes. The remaining ten ETGs that were populated in the study are represented in the table and discussed in detail below.

Table 4

Ungroupable ETGs

ETG #	ETG Description	Number of records	Percentage
999	Orphan ancillary records	497,200	44.90%
991	Orphan pharmaceutical records	273,670	24.71%
996	Invalid procedure code	211,071	19.06%
995	Invalid time period	100,521	9.08%
998	Inconsistent procedure and diagnosis code	9,576	0.86%
993	Invalid NDC	8098	0.73%
992	NDC is not pharmaceutical	6878	0.62%
997	Invalid diagnosis code	183	0.02%
970	Incomplete confinement	105	0.01%
989	No diagnosis code; procedure code requires one	55	0.00005%
	TOTAL	1,107,357	

The largest of the ungroupable ETGs is #999; orphan ancillary records. These are laboratory, radiological, and other ancillary records that could not initiate, nor could they join, an episode-of-care. The following table provides more details about the records grouped under ETG #999.

Table 5

ETG #999: Orphan Ancillary Records

Description	Volume	Percentage
Number of records	497,200	
Data source of the records		
MTF Laboratory	240,874	48.45%
SADR	164,977	33.18%
MTF Radiology	48,110	9.68%
HCSRN	43,236	8.70%
SIDR	2	0.00%
HCSRI	1	0.00%

The records in ETG #999 (497,200) account for 10.3% of the total number of records fed to the grouper and therefore warrant close examination. According to Symmetry Health (2000), these records indicate that the patient might be receiving care without the benefit of direct provider overview. They represent ancillary services that could not be linked to an appropriate interaction with a provider and therefore are labeled "orphans". Very few ancillary services are obtainable within the military healthcare system without a referral from a provider so there must be another explanation for the size of this ETG. In this study, the orphan records most likely indicate that the visit with the provider was somehow not included in the data even though the subsequent ancillary service was included. Perhaps the provider visit and the ancillary service occurred in two separate places and only the ancillary record was included in this study. There are two likely

explanations for this occurrence. The most probable is the absence of records in the original data pull from the two Branch Medical Clinics (DMIS ID 0231 and 0233) and the six months of data from the San Clemente clinic. Outpatient visits that occurred at any of these three facilities were not included, however, the ancillary records initiated during these visits were included because those records are maintained separately in CHCS. Unfortunately, the true impact of this phenomenon (lost outpatient visits) is unattainable without access to the missing records.

The other possible explanation for the number of records in ETG #999 are the more than 21,000 active duty service members who receive their healthcare from the medical assets aboard the ships homeported in San Diego (Region IX Lead Agent Office, 2001). Currently, very few ships in the San Diego area document their patient-provider interactions electronically. Active duty service members are seen aboard the ship and the care is documented in their paper healthcare record but is not electronically transmitted to a central database. Therefore, the outpatient visits for these beneficiaries and most of the laboratory and radiology services are not included in the study. A few laboratory and radiology tests, however, are handled differently and are included in the study.

Many of the routine laboratory studies that active duty service members require continue to be performed onboard the ship even while they are tied to the pier. Documentation of these tests is not included in the local CHCS system. However, more specialized laboratory tests (i.e. the test for HIV) are sent to NMCS D and therefore generate a record in CHCS just as they do during afloat missions (R. Coles, personal communication, March 6, 2001). In summary, laboratory operations do not change when ships pull into port. Because specialized laboratory tests are sent to NMCS D,

documentation of the test is entered into CHCS and therefore were included in the study. The most common laboratory test in ETG #999 is the test for the HIV virus; it accounts for 5% of all the laboratory tests in this ETG. The HIV test is routinely performed on active duty service members once a year but is not routinely administered to any other category of military beneficiary. Therefore, a small portion of the orphan laboratory records in ETG #999 could be attributed to active duty service members serving aboard ships homeported in the San Diego area. The impact of these orphan laboratory tests on the study can not be determined with the present lack of information systems aboard ships.

Many ships in the San Diego area have the ability to perform radiological studies and continue to do so whether in port or at sea. Although the tests are performed onboard the ship, a radiologist at the local medical center, NMCS D, is responsible for the "final" interpretation of the test. The Radiology Department at NMCS D receives approximately 3,500 radiological tests a year from the ships home ported in San Diego (E. Doern, personal communication, March 6, 2001). Although the radiological test is not performed at NMCS D, the test is entered into the CHCS information system when the radiologist at NMCS D interprets the results. The active duty service member's visit with the shipboard provider is not electronically documented anywhere but his/her radiological film is documented in CHCS. Again, the extent of the impact of these orphan radiological tests cannot be determined with the present lack of information systems aboard ships. However, it is certain that the lack of documentation of care provided to active duty is responsible for at least a portion of the orphan ancillary, both laboratory and radiological, records in the study.

The second largest category of records in ETG #999 are MTF outpatient records (SADRs) that represent procedures provided on an outpatient basis. There are no particular procedures that dominant in this ETG, however, one of the more common procedure codes is the administration of the flu vaccine. Flu vaccines are routinely given to large groups of people without an accompanying outpatient visit between the patient and his/her provider. The 4,848 flu vaccines represented in the data account for 3% of the SADR records in ETG #999. Regardless of the type of ancillary care included in ETG #999, the common theme is that the ancillary care is included in the data but the outpatient visit that generated the request for the additional care is not.

The second largest of the ungroupable ETGs is #991; orphan pharmaceutical records. The records in ETG #991 indicate medications that cannot be grouped to an anchor record to form the basis of an episode-of-care; i.e. orphans. Symmetry Health advises customers that these records usually stem from chronic prophylactic therapy (Symmetry Health, 2000).

Table 6

ETG #991: Orphan Pharmaceutical Records

Description	Volume	Percentage
Number of records	273,670	
Data source of the records		
CHCS Rx	273,271	99.85%
HCSRN	285	0.10%
NMOP	92	0.03%
SADR	22	0.01%

The vast majority (99.85%) of the records in ETG #991 were obtained from the CHCS information system. The top 30 medications by volume in ETG #991 are listed in Appendix L. Of the top ten medications on the list, nine of them are over-the-counter (OTC) medications. By volume, they represent 27% of the medications in ETG #991. An OTC dispensing program does exist in pockets in the San Diego area (A. Fryslie, personal communication, October 3, 2001). This could explain the relatively high volume of OTC medications that were not groupable to an episode.

Another source for orphan pharmacy records could be that the military pharmacies in the San Diego area fill prescriptions for medications written by providers outside of the facility. Many civilian insurance policies do not include a drug benefit. Military beneficiaries who have other health insurance (OHI) or Medicare (federal health insurance for individuals aged 65 and older) would be likely to utilize the free medication service available at the local MTF pharmacies. Regardless of the type of insurance they possessed, neither patient would have their outpatient visit recorded in the MHS system; that record would exist with their OHI or the Medicare system. Only the dispensing of the medication would be captured in the MHS information system. This would obviously lead to the creation of orphan pharmacy records and contributed to the number of records in ETG #991.

Another source of the records in ETG #991 might be individuals who choose to forego using their military benefits for doctor's visits and pay for their care out-of-pocket. If a patient pays the bill for his/her healthcare, the provider has no incentive to submit a

record of the visit for reimbursement. Essentially that care remains undocumented. If a patient saw his/her civilian provider and paid cash for the visit but utilized their military benefits and obtained the medication through an MTF, that would create an orphan pharmaceutical record. While the inclusion of these patients in this study is relatively certain, the degree of impact on ETG #991 is difficult to accurately determine.

While these orphan pharmaceutical records make up the second largest ungroupable ETG, it is important to be cognizant of the large volume of pharmaceutical records in the data. This study included more than 1.7 million pharmacy records pulled from the CHCS information system; the single largest source of records. Of this large number of records, only 273,670 (16%) were orphans and found in ETG #991. Therefore, 84% of the medications dispensed via MTF pharmacies were successfully included in an episode-of-care. Given the enormous quantity of medications that are dispersed by MTFs in the San Diego area and the attractiveness of the pharmacy benefit, the number of records in ETG #991 does not seem unreasonable.

The third largest of the ungroupable ETGs is #996; records which possess an invalid procedure code. See Table 7 for the source of these records. Ninety-nine percent of the records in this ETG fall into one of three categories and can be readily explained. First, the MHS uses military-specific procedure codes known as Champus-derived procedure codes. They were created for use by the MHS and are not found in the standard medical coding systems. Therefore, they are not recognizable by the episode grouper and fall into ETG #996. The Champus-derived procedure codes found in this study are listed in Appendix M. The majority of the records with Champus-derived procedure codes are those

mentioned previously in the paper; pharmacy claims submitted by drugstores in the civilian network. These pharmacy claims have an unrecognizable procedure code and have an unspecific diagnosis code attached to them also. Symmetry's episode grouper is unable to place these medications with any existing episodes-of-care because of the lack of adequate information.

Table 7

ETG #996: Invalid Procedure Code

Description	Volume	Percentage
Number of records	211,071	
Data source of the records		
HCSRN	165,717	78.51%
SADR	45,351	21.49%
CHCS Rad	3	0.00%

The next largest group (21.5%) in this ETG are records with "#EMPT" listed as the procedure code. Shorthand for "empty", this obviously is not a valid procedure code and so the records were placed in ETG #996. This error most likely occurred during the data import step. Without this invalid code, many of these 45,351 records might have grouped to an episode-of-care.

A small number of the records (4,175) in this ETG have Level III HCPCS codes. These codes were developed by Medicare carriers for use at the local level. Level III HCPCS procedure codes are not recognized by the episode grouper because they were

created to be defined and utilized at the local level. The codes range from #W0002 to #W0019 and account for 2% of the records in ETG #996. In future studies, these Level III HCPCS codes should be converted into a standard medical procedure (CPT-4) code before the records are sent to the grouper so that this care is included in episodes-of-care when possible. In fact, 23% of the records in this ETG could have been manipulated prior to grouping and the number greatly reduced. The other 71% (pharmacy claims with a Champus-derived procedure code and a non-specific diagnosis code) could be remedied if future pharmacy data came from a source that includes valid NDC codes. Such a system, known as the Pharmacy Data Transaction System, is underway within the MHS although the final implementation date is unknown. This system should greatly increase the MHS' ability to incorporate pharmacy data into episode grouper research.

The next most populated of the ungroupable ETGs is #995. This category represents the records that have dates of service that extend beyond the study period. The time frame for this study was fiscal year 2000. Records with a date of service before October 1, 1999 or after September 31, 2000 fall into this category. These 100,521 records were included in the data pulls despite the efforts of the technicians involved. In the future, they could readily be eliminated prior to sending data to the episode grouper.

The remaining six ungroupable ETGs contain very few records relative to the total number of ungroupable records. Combined, they represent 2.2% of the ungroupable records. The records in ETG #998 have valid diagnosis and procedure codes within the record but they are clinically inconsistent, see Table 8. This usually indicates a knowledge deficit on the part of the clinician/coder regarding medical coding. Interestingly, over a

quarter of the records in this ETG indicate a disagreement between a psychiatric procedure code and a prenatal diagnosis code. More than likely the women's health providers have a need to document their provision of significant emotional support but they are unaware of the proper codes for such an occurrence. Using a procedure code designed for use in the psychiatric setting is not appropriate. Examination of other records in this ETG could help identify other coding mistakes and possibly improve the overall accuracy of coding.

Table 8

ETG #998: Inconsistent Procedure and Diagnosis Codes

Description	Volume	Percentage
Number of records	9,576	
Data source of the records		
SADR	7,153	74.70%
HCSRN	2,309	24.11%
CHCS Rad	114	1.19%

The records in ETG #993 have invalid NDC codes. In this study, 47% of the records had an NDC code of a string of eleven zeros; obviously not a valid NDC code. The remaining 4,282 records represented only six different invalid NDC codes. Closer attention to the NDC codes placed in the pharmacy portion of the CHCS system would most likely reduce the number of records in this ETG.

Table 9

ETG #993: Invalid NDC

Description	Volume	Percentage
Number of records	8,098	
Data source of the records		
CHCS Rx	8,096	99.98%
NMOP	2	0.02%

ETG #992 indicates the records that have non-pharmaceutical NDCs. The vast majority of the records are military pharmacy records from the CHCS information system. This ETG contains twenty-six different NDCs. What the NDC code represents, if not a medication, is unknown. Perhaps consumable supplies used in the administration of medications, i.e. syringes, alcohol pads, sharps containers, etc. Research into the actual item(s) dispensed, along with recoding, would be required to reduce the number of records in this ETG.

Table 10

ETG# 992: NDC is Not Pharmaceutical

Description	Volume	Percentage
Number of records	6,878	
Data source of the records		
CHCS Rx	6,877	99.99%
NMOP	1	0.01%

Invalid diagnosis codes are found in ETG #997. Twenty-six different codes are represented in this ETG. As with any invalid codes, closer attention to proper coding or a coding system that does not allow invalid codes to be entered would reduce the number of records that possess invalid codes.

Table 11

ETG #997: Invalid Diagnosis Code

Description	Volume	Percentage
Number of records	183	
Data source of the records		
SADR	125	68.31%
SIDR	58	31.69%

The records in ETG #970 represent hospitalizations that extended beyond the dates of the data pull. The episode grouper acknowledges that the patient remains hospitalized after the data stream ends and placed the record in ETG #970 to be grouped with a later data feed. This ETG need not be examined because it contains records that rightfully belong in it and should not be included in episodes-of-care.

Table 12

ETG #970: Incomplete Confinement

Description	Volume	Percentage
Number of records	105	
Data source of the records		
SIDR	88	83.81%
HCSRI	17	16.19%

The final ETG, # 989, contains very few records. These records lack a diagnosis code although the procedure code requires one. All of the records have a procedure code of “unlisted miscellaneous pathology test” but no diagnosis code. Investigation into laboratory coding procedures may reveal the reason for this miscoding.

Table 13

ETG #989: No Diagnosis Code; Procedure Code Requires One

Description	Volume	Percentage
Number of records	55	
Data source of the records		
CHCS Lab	55	100.00%

Discussion

A review of the ten ungroupable ETGs illuminated many possible reasons for the number of records they contained. The most significant numbers were due to orphan records and invalid medical codes, 70.5% and 19.8%, respectively. The high number of

orphan records found in the study may be attributable to several populations whose patient-provider interactions were not captured in the data. These populations include: (a) those who received care at one of the two medical clinics not represented in the data; (b) those who received care at the San Clemente clinic during the time patient encounters were not transmitted to the central database; (c) active duty service members stationed aboard ships homeported in San Diego; (d) the 65 and older population that receive their outpatient care from civilian Medicare providers but utilize ancillary and pharmacy benefits within the MTFs, and (e) military beneficiaries who use OHI for their provider visits but utilize the MTFs for their ancillary and pharmaceutical needs.

Another potential cause for many of the orphan records is the system used by the MHS to transmit data to the central database in Fort Dietrich, Maryland; the Ambulatory Data System (ADS). At the time of the study, this system was paper-based and quite difficult to operate efficiently. Errors were made and healthcare encounters went undocumented and were therefore lost to researchers. The future ADS will be computer-based and less cumbersome. Under this more automated system, it is anticipated that a greater percentage of the outpatient care at the MTFs will be accurately documented and stored for later retrieval. This, in turn, should lead to a higher percentage of records that can be incorporated by episode groupers into episodes-of-care.

The mobility of the military population served might also have contributed to the number of orphan records found in the study. Active duty service members and their families are certainly encouraged to move more often than the average civilian family. This makes complete capture of the data very difficult. The only remedy would be to include healthcare encounters from the entire MHS in the data.

To a lesser degree, invalid medical codes were responsible for the records in the ungroupable ETGs. Some of the medical codes used were truly invalid and do not appear anywhere in the medical coding literature. The majority, however, are codes that represent something specific but are not recognized by Symmetry's episode grouper. These include the Champus-derived procedure codes, Level III HCPCS codes, and MTF-specific procedure codes. Transforming these codes into ones recognizable by Symmetry's episode grouper would greatly enhance the performance of the MHS data. In addition, computerizing the ADS system so that it refuses invalid codes, increasing provider education regarding proper coding, and/or designating more of the responsibility for coding to professional medical coders would increase the quality of coding within the MHS. This, in turn, would likely lead to a reduction in the number of records being labeled invalid. Concentrating efforts on either area highlighted above, orphan records or invalid medical codes, has the potential to greatly impact the number of records relegated to the ungroupable ETGs. If the number of ungroupable records is lowered, the quality of the episodes-of-care created would be higher because the episodes more accurately reflect all of the care delivered to individuals. Complete and comprehensive episodes-of-care are essential before additional experimentation with episode groupers is conducted.

Recommendations

Episode groupers should continue to be studied because of the potential to greatly improve operations within the MHS. However, there is much work to be done before episode groupers can be relied upon to augment the current modeling efforts or assist in other areas of healthcare management. Future testing should be rigorous and consist of four stages. First, a study similar to this one should be conducted incorporating the lessons

learned. The percentage of records that group to an episode-of-care would most likely rise dramatically and perhaps reach the civilian benchmark. Once the episodes-of-care are deemed complete, the second stage of testing could begin.

The reliability of the episode grouper software needs to be addressed. The test for reliability would be to send the same information through the episode grouper more than once and determine if the data was handled in a similar manner each time. If the data was placed into the same ETGs each time, the case for the product's reliability can be made.

The next step would be much more difficult but is essential before the episode grouper software can be utilized for decision making. Drs. Rosen and Mayer-Oakes (1999) expressed concerns that none of the episode groupers on the market had undergone rigorous, independent validity testing. Validity indicates that the product does what it purports to do. Symmetry Health claims that, through its patented process, healthcare encounters provided in the treatment of the same illness/condition are placed together into episodes-of-care. In addition, the episodes-of-care are placed into one of 584 groups, the ETGs, that adequately compensate for patient acuity. The test for patient acuity would be to examine the care that patients in each ETG receive to see if they routinely consume a similar amount of resources. Close examination might indicate that the ETGs are too general; that patients within the ETG are not similar enough in resource utilization to facilitate meaningful comparisons. Testing for validity would be very demanding and require a great deal of clinical expertise. However, this step is essential before episode groupers are utilized in decision making.

Once the validity and reliability hurdles have been cleared, many of the data quality issues that plague the MHS may have been resolved. In addition, information system

improvements mentioned earlier (computerization of the Ambulatory Data System and the introduction of the Pharmacy Data Transaction System) will have been implemented and allowed to mature. Any of these factors have the potential to greatly increase the accuracy of the episodes-of-care constructed. At this point, it would be feasible to use episode grouper output as the basis for the next wave of healthcare system models. Symmetry Health's ETGs, minus the ungroupable ones, could be carefully examined to look for patterns. Since all the information is computerized, queries can be conducted to determine the parameters inherent in each ETG. A modeler could calculate averages for parameters such as:

1. Episode length.
2. Number and spacing of visits to the provider.
3. Number and types of laboratory tests performed.
4. Number and type of radiological tests performed.
5. Medications prescribed and in what sequence.
6. Surgical interventions performed.
7. Hospitalizations involved.
8. Length of hospital stay.
9. Number and type of complications experienced.

This "average" episode-of-care could be used as the treatment pattern for that medical condition (ETG) within a computer model.

As noted before, the quantification of healthcare delivery patterns is the fundamental building block of the current MHS model. Currently, these patterns are constructed by combining aggregated MHS data and clinical expertise. Using an episode

grouper would automate the process of episode-of-care construction thereby reducing the amount of manpower involved. In addition, it has the potential to greatly enhance the accuracy of the healthcare patterns. If the accuracy of the fundamental building block of a model improves, the entire product improves and better decisions can be made using computer modeling and simulation.

The MHS will always have a need to understand patterns of care in order to wisely manage such a large, complex healthcare system. If episode groupers can survive rigorous reliability and validity testing, they will be of immense value to healthcare administrators everywhere. Now is the time to conduct such testing because as data capture in the MHS improves, the demand for tools to assist in analysis will only increase.